



## STANDARDIZATION, A DORMANT TREASURE

By G. WALTING

*In his article "Can America Do It?" (in our issue of May 1942), G. Walting analyzed the ability of American industry to carry out President Roosevelt's huge armament orders. Mr. Walting's careful appraisal of what America can and cannot do has stood the test of subsequent developments.*

*Here the author discusses a lesson to be learnt from America—the advantages of standardization. While in the main he compares America and Europe, part of what he has to say applies also to East Asia. Although he points out America's advantages, Mr. Walting also sees the limitations of standardization and, looking at the question from every angle, draws some interesting and weighty conclusions.—K.M.*

**F**ROM my window in a tall apartment house on Riverside Drive in New York, I could look down on one of the principal approaches to the business sections of the city. Today the lack of gasoline in America has changed the picture, but before the war one saw throughout the day a smoothly moving stream of cars. The sight was especially impressive after dark. On the two bands of cement, one for north- and one for south-bound traffic, two streams of automobiles followed their course like rivers. On the one band you saw the dimmed glare of headlights, on the other the red dots of taillights, making regular interruptions in the endless chain of cars. The black dots moving along at the same speed were all of the same size. Each car kept its place, and no one tried to pass, since it was practically impossible to do so. The traffic rolled along without a break on this highway, reserved exclusively for private cars. To the layman, it seemed like a picture from a technical dreamland. But if you happened to be an engineer you saw in it a perfect example of standardization.

Traffic of such density and smoothness was only possible in the USA where the

vehicles are uniform, that is to say, where there are only automobiles on the road, all more or less alike and of the same size, power, and pick-up. In Europe, the many different kinds of automobiles to be found prevent traffic from being regular, since one car is faster than the other and the cars of different sizes cannot form such smooth bands of traffic as are to be found in New York. There are Opels, BMW's, Adlers, Steyers, Fiats, Citroëns, Renaults, Tatras, Austins, and Morrisies, all midget cars, beside Mercedes, Horchs, Minervas, Daimlers, Hispano Suizas, etc. And if, in addition to this, there are busses, trams, trucks, horse-drawn vehicles, bicyclists, and perhaps even handcars on the road, then traffic naturally cannot be smooth.

In the USA the uniformity in the manufacture of automobiles has reached a very advanced stage. Three of the eleven American motorcar manufacturers, namely, General Motors, Chrysler, and Ford, are together responsible for 90 per cent of the entire American automobile production; and their low-priced models, the Chevrolet, the Plymouth, and the Ford, called the "Big Three," are all practically of the same price and quality. This

concentration of automobile production has made standardization comparatively easy. It was applied above all to individual parts, screws, material, general questions of construction, electrical and other accessories. A large number of individual parts are identical.

#### DIFFERENT CARS, IDENTICAL PARTS

Through mass production and standardization, the manufacture of automobiles in the USA has become essentially a process of assembly. The main work of the large automobile factories consists of assembling half-finished products which stream into Detroit from countless motorcar-parts factories. For instance, the chassis frames of the Chevrolet and of the Ford are identical and are manufactured by the same supplier. General Motors and Ford both get deliveries of several thousands of these frames at a time.

Or, to give another instance, in 1940 a manufacturer brought out a new headlight in which the bulb and the reflector were contained in a single airtight unit. This device prevented dust from getting into the lamp. The new headlight was introduced by all automobile manufacturers in that same year in practically all new models. Thus in the case of accessories the effects of standardization are even more apparent, since they are often used by the entire automobile industry and not only by individual companies.

The mass production made possible through this renders the individual parts cheaper and thus also the automobile composed of these parts. It is not the ambition of the American manufacturer to make everything in his own plant; he is only interested in producing the numbers needed in the cheapest and best possible manner. And this system cannot work without standardization. The spirit that is behind this method of manufacture is expressed in the words of Henry Ford: "Any customer can have a car painted any color that he wants so long as it is black." This spirit has even overcome the objections of the owners of

patents. The automobile manufacturers of the USA have agreed on the reciprocal use of their patents, whose number was already 1,687 in 1930. The result is that the purchasing price of an American car contains on an average not more than two dollars for license fees. Standardization has won.

#### CRANK SHAFTS AND PLUGS

The excellently developed customers' service and the availability of all spare parts in the vast expanse of the USA, even in the thinly populated Southern and Western states, would be unthinkable without this standardization. Who has not heard of the European motorist who, after driving across a border, had to wait for a spare crank shaft to replace his broken one, and who succeeded after much telephoning and telegraphing in having it sent to him by express or by plane from the factory or from its nearest service department? The reason for this delay is lack of standardization.

Electrical-supply stores in the capitals of Europe have for sale traveling irons and heating pads which can be used for three or even five different voltages, so that the traveler may use his electrical apparatus in all the cities on the Continent, which have differing voltages and kinds of current. Of course, the cautious traveler who has bought such a universal apparatus may still have the misfortune, after setting his iron or his heating pad for the voltage at his destination, of not finding any wall plug to fit the plug on his apparatus. And this may be the case if our traveler is only a day's trip away from home.

#### 19TH-CENTURY BORDERS VS. 20TH-CENTURY ECONOMICS

The frontiers of Europe were drawn by politics. They have nothing to do with economic laws. The partition of the European continent into a large number of markets with their own economic authorities has made the formation of a uniform market for all Europe impossible. Every government supported its own industry. The individuality of

the European nations was overemphasized, and that which was common to all was overlooked. This attitude stood in opposition to technical developments. The technical uniformity of machinery grew constantly, and with it the size of the individual plants. The range of a 100,000-kilowatt turbine of our times is far greater than that of a power station built in the years around the turn of the century. Until very recently, no economic changes have taken account of this technical development. It had never been considered that neglecting to adjust the markets to the growing technical uniformity must necessarily lead to tension and to the tendency of the constricted economies to expand across the borders of the nation, a tendency which has contributed largely to the events of our times. Europe's industry is crying for a large market that corresponds to its efficiency and the high level of its technology. It demands its own economic *Grossraum*, and the prerequisites for this *Grossraum* are standardization and uniformity.

#### COMMON STANDARDS FOR 18 COUNTRIES

Since 1926 an international association of the standardization committees of various countries, called the "ISA" (International Federation of the National Standardizing Associations), has existed with its seat in Basel (Switzerland). In it are represented eighteen countries, fifteen of which are European, the other three being the United States of America, Japan, and the Soviet Union. (The United States had in 1939, according to the American Iron and Steel Institute, a steel production of 52.8 million tons, which was manufactured under one set of standards, the American. According to the same source, the total production of the continental European countries amounted in 1939 to 50 million tons, which, however, were manufactured not under one but under fifteen sets of national standards!)

The forming of the ISA represents a good beginning; but, after all, it is only a proof of the differences on the European continent. Otherwise there would have been no reason to create such an organi-

zation. The argument may also be raised that, among the fifteen sets of standards of the fifteen European countries, there are some standards which are identical. But this does not change the fact that the United States has a huge advantage, reaching into every factory, every workshop, every home, in her uniform manufacture of so important a raw material as iron, when compared to the nonuniform manufacture of the same quantity of steel in European countries.

#### AMERICA AND THE INDIVIDUAL

Conditions for standardization are nowhere as favorable as in the United States, with its 130 million people speaking the same language and with its economic territory of 48 States extending across many latitudes of the most varied climates. The success of mass production was founded on the readiness of the general public to accept uniform products, which enabled industry to limit the number of its types. The American Standards Association (ASA), the highest authority for industrial standardization in the United States, is composed of 72 national organizations in the form of technical and commercial associations as well as public institutions. It has 2,000 member-associations, and the entire organization employs about 3,000 people dealing exclusively with questions of standardization. A combination of favorable circumstances has promoted standardization in the United States and has made that country an interesting object of study for any standardizing engineer.

Even the most superficial observer of the United States is bound to notice that, in comparison with conditions in Europe, there is greater uniformity in many spheres of industrial production and daily life. This conforming to type is to be found, not only in the case of technical products, machines, and consumption goods, but also in the case of streets, houses, the appearance of towns, and in manifestations of private life such as clothes and taste in general. For most Europeans, this goes too far. Is the idea of standardization to kill off every personal note? Is the appearance of every

street, the course of every day, to be molded into one form? Is that which is personal in an achievement, in a thought, that which is, after all, the highest expression of creative initiative and thus of all progress, to be violated?

The penetrating of standardization into private life causes one to ask where the limits for standardization are to be set in order to protect the creative liberty of the individual. The American way of life challenges the European observer to put this question. Indeed, the reply to this is of the utmost importance in appraising standardization. But before attempting to give it, we must first discuss a few basic facts.

#### WHAT IS STANDARDIZATION?

First of all: what is standardization? Standardization is any agreement on size, measurements, quality, or value of products. The purpose of standardization is to save material, decrease stocks, and by these means to reduce and speed up the turnover of capital, to limit overhead expenses and to reduce waste of labor. Standardization attempts to make the best available technical solution a law to be followed by all.

The standardization of technical definitions, units of measurement and weight, specifications, and conditions of delivery facilitate trade and commercial relations, and the standardization of machines, individual parts, and types makes their manufacture cheaper, a fact by which both producer and consumer benefit. Through a comparison of the fastest selling cars and refrigerators in Europe and America—i.e., in territories of partial and complete standardization respectively—and taking into account the differing weights of these products in the two territories, it has been calculated that the price per pound of each product is 2.2 to 2.3 times higher in Europe than in America. In other words, through complete standardization and real mass production, the price of European automobiles and refrigerators could probably be cut in half.

#### ITS RANGE

In all its economic interdependence, standardization forms an integral part of modern economic thought. The necessity for it arises with the growth of industrial manufacture and the growth of economic areas. The smallest unit that can be standardized is the individual plant. The next largest group is made up of those standards on which the manufacturers of one industrial branch agree. National standards are limited by the borders of a country; while, finally, international standards are accepted by many countries all over the globe. The greater the range of a set of standards, and the greater the number of those who have to agree on a uniform type, the more difficult is it to enforce such standards. Hence for the success of a standardization it is very important first to make certain of the most practical range for the standards in question. Often it is wise to limit this range.

#### TOO LATE AND TOO EARLY

Of equal importance to the success of a standardization is the choice of the proper time for setting up the standards. As long as a product is at the stage of technical development and can still be improved on, its fate should be left in the hands of free competition. Its standardization should not be discussed until the product has reached so high a technical level that no notable improvements are to be expected from competition. There is a point in the technical development at which neither the purchaser nor the manufacturer should be interested in further efforts at development. When the product fulfills the practical requirements of the purchaser, he is from then on mainly interested in a reduction of the purchase price of that product. This reduction, however, is far more easily achieved if the product is standardized and the manufacturer can start mass production. If no standardization is brought about and the development is continued for reasons of competition, the product has to bear the costs of this development.



If at this stage standardization is delayed for some time, we have the case of a retarded standardization. The rival manufacturers have then specialized to such an extent on their own constructions that the change-over to a uniform construction, entailing changes in drawings, installations, tools, and machinery, becomes difficult, expensive, and tedious. To this must be added the losses through devaluation of invested capital. A good example of retarded standardization is the existence of direct current in the electric-light net of some European cities or parts of cities beside the universal alternating current: the desire for standardizing the electric network on alternating current is there, but, because of the high costs entailed by a retarded standardization, it can only be carried out gradually.

However, there are also cases of premature standardization. They arise in times of boom. Then we have a tremendous demand for deliveries, and all available labor is needed for production. Standardization carried out at this stage consciously puts a stop to development, which, for the moment, has become unimportant. On the other hand, so much capital is invested in the process of manufacturing the standardized product that, again because of the possible devaluation of invested capital, it forms a restraint on making use of later inventions leading to the improvement of the product. In 1927, for instance, the members of the National Electrical Manufacturers Association in the USA agreed on standard dimensions in the construction of electric motors. Since then, all three-phase motors have been manufactured according to the same standards and are interchangeable. Meanwhile, however, the German electrical industry, which is not standardized, went on in its development of insulating materials and improved its constructions, with the result that today the German electric motor is smaller and lighter than the American one of same power. And the American manufacturers are finding it difficult to change their standards to conform to the new insulating materials. Thus an unstandardized

condition can be advantageous for technical developments and lead to improvements on models which in other economic areas have been, so to speak, frozen by standardization.

#### ENEMIES OF STANDARDIZATION

In this respect, the engineer is an enemy of standardization. His urge to invent and his technical ambition do not let him rest. There is no construction that to him is near enough to perfection. No form is good enough to be standardized and thus be set up as a universally binding example. The engineer reckons in degrees of effectiveness. His reason tells him that an effectiveness of 100 per cent cannot be achieved, and yet his imagination does not let go of this value. Hence the stage of development at which a product is ready for standardization should be determined by economic factors rather than technical ones.

Another force opposing standardization is competition. The private interests of each manufacturer lead him towards ensuring the greatest possible share of the market for himself. In following this aim, he wants to feel no restraint whatever toward his rivals. Moreover, standardization and competition are bound up by another economic relationship. When an article is standardized, the ensuing fixing of the process of manufacture gives the largest among competing producers the best chance to reduce his manufacturing costs by the greatest possible mass production. Through spreading his fixed charges over a large turnover, the largest producer can lower his prices more than his smaller competitors. In this way, his competitive position is automatically and increasingly improved. The competitor gradually becomes the owner of a monopoly. Developments of this kind have led directly to the formation of industrial trusts.

Finally, we must consider the attitude of the patent owner towards standardization. The patent protects mental property; thus it supports the individual achievement and assures the inventor of success. Standardization, on the other

hand, places the best technical solution at the disposal of everyone. In this sense, patent and standardization are hostile to each other. As long as there is free competition, one invention leads to the next. Every inventor tries to outdo his competitors and to protect his solution with all available patent rights. Only when his invention and its protection are so comprehensive that no competitive solution can exist, i.e., when he has become the owner of a monopoly, do his interests coincide with those of standardization.

#### THE AUTOMOBILE AS AN EXAMPLE

The final criterion for the limits of standardization and for deciding inevitable differences among contrasting interests can only be the rational demarcation between private and national economic thought, between personal advantage and the advantage of all. This is where standardization finds its organic place in the theories of planned economy. It is hard to imagine that the correct judgment on the degree of development, on desirable competition, or on the suitable moment for setting up a standard, can be formed without the introduction of a higher authority which takes into consideration the interests of the nation. It is true that standardizations have also been carried out through private initiative in organizations led by private interests. Full exploitation of the blessings of standardization, however, is only conceivable when this private initiative has been brought into harmony with national demands. For the profits obtained from standardization undertaken by private interests do not always coincide with the interests of national economy as a whole.

The technical development of the American automobile industry followed the principles of private competition, without much regard for national economic interests, as, for instance, the saving of fuel or steel. Not until last year did the Americans, the owners of the richest sources of oil and the greatest steel industry, realize that the earth's

reserves of oil are limited and that steel can get scarce. They liked their cars large and luxurious and felt that they could afford them that way. Thus it was natural that, in spite of the constant improvement of automobiles in the years from 1926 to 1938, no appreciable reduction in the gasoline consumption per mile or in the use of steel was brought about, although the total running costs were reduced and the cost of repairs went down 67 per cent.

In the same period, however, Europe, particularly Germany, with the intense competition among a far greater number of manufacturers, produced cars with a gasoline consumption of one gallon to almost forty miles. The German cars have only about a third of the gasoline consumption of the American cars, while their weight amounts to only 800 kilograms as compared with 1,300 kilograms for a Ford. Hence they save raw materials, fuel, and parking space. The American automobile industry has long realized these advantages.

#### VESTED INTERESTS IN THE USA

Outsiders in the American automobile industry, such as Willys, Hudson and, only a few years ago, Crosley, have repeatedly tried to enter the American market with small cars. None of them succeeded. Even Ford, who builds small cars in his European factories and who still has a 20-per-cent share of the entire American automobile business, would not be able to put over so revolutionary a change as the introduction of a small car in the USA against the resistance of General Motors and Chrysler. The reason for this is that the American manufacturers have their own sales organization and that most new cars in America are sold in exchange for old ones. In this way, American automobile manufacturers indirectly own a large proportion of the secondhand cars in America. The successful introduction of an entirely new type of car would immediately devalue all the secondhand cars on the market, which would mean a loss of capital that no privately controlled industry could bear.

It would, of course, be an entirely different matter if this depreciation could be made at the cost of the general public, and it does not take much imagination to predict that the present war will be made use of to clear the market of old cars. The present shortage of gasoline is another impetus for introducing a light, fuel-saving car. I am sure that, as soon as the problem of depreciation has been solved, the United States will abandon her standardized large cars and change over to a standardized fuel-saving, smaller type.

#### THE OUTLOOK IN EUROPE

The situation is entirely different in Europe and especially in Germany, which country is the largest manufacturer of cars on the Continent. The competition among all manufacturers has led to a construction which, although created in private competition, at the same time, through farsighted guidance of this industry by the State, takes national economic demands into consideration. From the point of view of traffic and distances, the small car is suited to European conditions and corresponds to the greatest technical demand of this economic sphere—the demand for economy in raw materials. Now this type has reached a stage in its development which makes the industry ready for standardization. The introducing of mass production, for which standardization is essential, must necessarily lead to an increased efficiency in the factories, to a lowering of the costs of production as well as of the running costs, and to a boom of considerable extent.

In 1940 the automobile production of the USA amounted to 4.4 million cars as compared to 0.66 million cars produced in Europe in 1938 (the last year available for comparison). In the United States there was one car to every 4 inhabitants in 1941, while in continental Europe there was one car to every 47 inhabitants. These figures represent the difference between a motorized and a not yet motorized economic area. With 31.1 million cars registered, the American market had approached the point of saturation, and

the new production of cars served mainly to replace old cars. Europe, on the other hand, can still absorb a huge amount of cars and will, for many years to come, be employed with building them. We need only look back at America to realize what this means for the future development of the European automobile industry and all the other branches of economic life that are directly or indirectly linked up with it.

#### FROM TRACTORS TO BOTTLES

This one example is enough to show the advantages to be derived from standardizing one industry for all of Europe. The detailed work undertaken by the permanent commissions of the ISA for the purpose of adjusting the standards of eighteen national industries to each other speaks for the trend toward standardization in all branches of industry. 28 commissions are working out standards for agricultural machinery, the steel and iron industry, aeronautics, ball bearings, couplings, pipe lines, screws, threads, fittings, wedges, crank ends, and paper sizes, to name just a few technical branches.

The standardizing organs of German industry are represented by the *Deutsche Normen-Ausschuss* (DNA), the German Standards Association. The DIN (*Deutsche Industrie-Norm*) sheets issued by this organization, of which there are so far more than 3,000, deal, aside from the main industries, with such specialized spheres as fire departments, photography, libraries, hospitals, the manufacture of bottles, etc. There is no industry which has not yet been affected by the advancing wave of standardization. All industries wish to employ its advantages in order to reduce the price of their products.

#### FROM THE BOTTOM UP

In contrast to the methods of standardization in America, where a single industry generally agrees on standardizing the finished product and then works backward in standardizing the individual parts down to screws and bolts, the German industry as a whole started off with typical thoroughness by standard-

izing these smallest individual parts for all industries. Thus, although there is no finished product in Germany as standardized as the American automobile, screws and threads and many other parts are absolutely standardized in Germany for all industries. The work of the German standards organizations in turn has influenced the other European states, which in many cases are using the standards of the DINA. This leading position within the economic system of Europe has been held by Germany for many years.

Another impediment to this development in Europe was the divergence of official regulations in the various countries. Building regulations, regulations for taking delivery, safety regulations, and construction regulations, are other forms of standardization. They are usually the result of co-operation on the part of manufacturers, consumers, and public bodies. Such regulations are of decisive importance for technical developments and trade.

The construction of electrical-installation material, for example, is practically fixed by the existing building regulations of the economic area in question. At one time, no less than eleven countries on the European continent (Holland, Belgium, Switzerland, Luxemburg, Denmark, Sweden, Norway, Italy, France, Finland, and Germany) had their own regulations regarding the installing of electrical equipment. Moreover, these regulations did not always apply to the whole country: within the countries there were also special regulations for provinces, districts, and even cities. (In the USA there is only a single set of regulations, the National Safety Code of the Bureau of Standards.) The European exporter must keep count of all these regulations and observe them in his construction, which naturally makes the latter more expensive. In spite of this, it constantly happens that the exporter experiences difficulty on delivering his product because it does not comply with some local regulation or other.

#### STANDARDIZATION IN THE KITCHEN

A good example for the co-operation of parallel industries in an economic *Grossraum* is the standardization of the modern kitchen and its equipment in the United States. The manufacturers of gas cookers have not only standardized their own types but have even made them uniform with electrical cookers. Moreover, household refrigerators, sinks, and kitchen furniture, with dimensions for the height and width of tables, etc., have been standardized, so that outwardly there is no difference between a modern gas or electric kitchen. The consumer is free to choose between gas and electricity for his cooker, refrigerator, etc. In any case, the utensils and furniture match. The advantages of this uniformity for the architect are obvious, and the limitation of the number of types permits mass production and reduces the cost.

The comparison of standardization in economic areas of various sizes shows that standardization is an economic factor. Standardization is by no means limited to fixing construction; it extends to questions of manufacture, to problems of economy and distribution. In short, it is a general technical and economic attitude. Standardization includes the adjustment between private initiative, freedom of the purchaser, and subordination to the common weal. Its task lies in the sphere of order. Its importance grows with the growth of industrialization, the level of engineering, and the extent of the markets. It presupposes the economic *Grossraum*. This is the reason why the nations of Europe have so far found it impossible to make extensive use of this economic factor. The new order of Europe will, for the first time, open the doors of this vast market to the employment of standardization on a broad basis, which alone will make its real success possible.

#### STANDARDIZATION AND INDIVIDUALISM

The question remains whether the creative activity of the individual will not be fettered by the schematism of standardization. The answer to this question



can only be in the negative. This sphere of creative invention is remote from the field of the standards engineer. A product is never ripe for standardization as long as it is still in the hands of the inventor or is still the object of technical development in the hands of the constructive engineer. Standardization deals only with the ordering of details whose shaping is no longer the object of creative work and which represent only the parts with which creative power builds new things.

Although, as a result of standardization, the architect may be forced to use bricks of a certain size, no one will say that he would thereby be hindered in his architectural occupation. He is entirely free to decide on form and planning as well as in the choice of the color and kind of his material. The standardization of the size of bricks relieves him of dealing with this subordinate question, the clarification of which, however, makes it possible to produce building materials economically, to reduce the price of such materials, and thus assists him in carrying out his profession. Standardization is not an end in itself but a servant of the creative activity of the individual.

Those who shudder at the uniformity of standardization need not fear for the freedom of thought of the creative spirit. This anxiety is natural. Europe, the center of Western culture, will always see as its great task the fostering of ideas and sciences. Hence the uniformity of America is apt to scare the European. However, the introduction of standardization is an economic necessity and need not alter the nature of Europe's spiritual life. From Europe came the inventions of the combustion engine, the automobile, the Roentgen tube, and wireless telegraphy, while the technical manufacture and employment of these inventions has progressed furthest in the United States. There is no reason why Europe, the cradle of so many other inventions, cultural achievements, and spiritual creations, should not, after having organized its

own economic *Grossraum*, make use in the same measure as the United States of the practical employment of its inventions without giving up its individuality and without losing its creative gift.

#### EUROPE'S OLDEST STANDARD

There is one standard that Europe was early to introduce. In 1793, French scientists suggested the measurement of the meter, which is the fortieth-million part of the circumference of the earth. It took almost a century for it to be recognized internationally at the Meter Convention of May 20, 1875. Since that date it has been used throughout the industrial world, except in Great Britain and the USA (in the latter country, however, it is officially recognized beside the system in use). The original meter consists of a platinum-and-iridium bar kept at a constant temperature in a cellar of the Pavillon Breteuil at Sèvres near Paris. The grounds in which the pavilion stands are extraterritorial and have been declared international soil. All members of the Meter Convention possess the closest possible copies of the original measure in Sèvres.

Thus the meter, the basic standard of continental Europe, stands as a symbol for the will to collaborate at the beginning of a new economic era which will have as its starting-point the economic unification of the nations of Europe. That which has brought together the scientists must be transferred to the sphere of mechanical production. The share of industrial production in the total production of the world is so great that the savings to be effected by standardization represent a source of wealth for all those nations which accept it.

The *Grossraum* of Europe is opening up the advantages of standardization for all nations belonging to it. In the hands of the engineers entrusted with this task, the meter, this symbol of standardization, will become the magic wand, the "Open Sesame!", with which they will lift dormant treasures.

